

IN THE SPECIFICATION:**IN THE BACKGROUND OF THE INVENTION:**

There is a need for a backup power source to maintain operations when the primary power source shuts down in some industries, such as the telecommunications industry. These systems generally comprise batteries, for example, of a predetermined size such as 2 volts, which are typically connected in series in various numbers and patterns and stored on racks. A typical array may comprise 24, 2 volt batteries providing a 48 volt system. An important criteria for these rack systems is that the rack functions to support the heavy loads and be of a sufficiently strong and reliable design to be reliable in times of crises particularly a seismic crisis. Another consideration is that the battery racks be of a design to take up as little space as possible. In other words, the goal is to achieve more power at less cost thereby maximizing power per square foot of floor space. For example, typical prior art rack designs have widths equaling the battery width plus about 10 inches additional space for the rack elements housing the batteries. The rack design of the present invention by contrast reduces width considerably to the width of the battery plus about a total of 4 inches added to the width for rack elements. The acronym MFR is used herein and stands for minimum footprint rack. Variants of the acronym MFR include designations such as 1A, 2 and 2A for the various embodiments.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and particularly to Figs.1-4 thereof, there is shown a first embodiment of Battery Rack in accordance with the present invention generally designated by the numeral 13 which supports a plurality of batteries 12 in the manner shown in Fig. 1. The Battery Rack is characterized by novel features of construction and arrangement so that it is capable of withstanding high seismic forces and loads and is configured to provide a minimum footprint (MFR-1) occupies a minimum space as compared with prior racks used for this purpose. For example, the rack design accommodates a total of 24 C&D LCT-2320 2 volt batteries in an 8-foot square room to produce a 48 volt system. The Battery Rack 13 shown in Fig. 1 supports 8, 2 volt batteries forming a 16 volt subsystem so that 3 such racks can be positioned in a U-shaped configuration in an 8 foot square room and wired in series to produce a 48 volt system which is standard in the telecom industry. Further, the rack design is capable of withstanding earthquake forces up to levels required by the Network Equipment Building Systems (NEBS) Zone 4 requirement of the Telcordia GR-63-CORE specification, which is the telephone industry standard for seismic requirements.

Considering now the specific structural arrangement of the Battery Rack 13 and the rack comprises two end frames, spaced apart and facing one another. Each end frame 1 comprises a pair of spaced angular support members 6, upstanding Cchannel shaped support rails 2 spanning the end frames 1 in a longitudinal direction and to support in the present instance 2 rows of batteries 12 in upper and lower tiers. Specifically, the battery

support rails 2 are secured by bolting at opposite terminal ends to upper horizontal channels 7 spanning the upright vertical angular members 6.

Elongated shock rails 3 of generally inverted C-shaped cross section are bolted to the inside face of vertical angular members 6 so that the channel 3a faces outwardly and presents a planar flat support surface to the batteries 12. In the present instance, 2 shock rails 3 are provided for each tier of batteries. Diagonal braces 5 and 6 are provided which crisscross and are bolted to the outer side face 6a of the angular vertical members 6. This arrangement provides lateral stability and a compact design contributing to the minimum footprint in a width wise direction W as shown in Fig. 1a. The shock rails 3 provide lateral restraint to the batteries in the front to back direction. The end rails 4 similar to the shock rails 3 are of ~~inverted~~ C-shape cross section and are bolted to the vertical members 6 so that the channel 4a faces outwardly and the planar face of the end rails 4 engage the batteries in the manner shown to restrain lateral movement of the batteries in the side-to-side direction. In this embodiment, the 2 tiers accommodate four 2 volt batteries 12 which connect in series to provide a 16 volt subsystem. As noted above, ~~3~~ three of these subsystems may be connected in series to produce a 48 volt system. As set forth above, the angular vertical members 6 are provided with a plurality of mounting holes H for the shock rails 3, end rails 4 and diagonal braces 5.

The base assembly B comprises a generally rectangular base plate 10 having in the present instance four (4) anchor holes 10a at the corners of the base plate 10. Trapezoidally shaped gussets 9 with brace holes 9a strengthen the joint between the vertical uprights 6 and the base plate 10. The brace holes 9a of the gussets 9 are aligned with brace holes 6a on the outer vertical flanges of the angular vertical members 6. In the

present instance, the base B includes a pair of triangular gussets 11 which are welded to the vertical uprights 6 and are spaced inwardly from the mounting holes 10a of the base plate 10 and are welded to the end face of the upright members 6 being disposed parallel to and offset relative to the trapezoidal shaped gussets 9 towards the interior of the end frame 1. The components comprising the base assembly B including the base channel 8, trapezoidal gussets 9, triangular gussets 11 are welded to produce the unitary rigid assembly shown in Fig. 3.

The Battery Rack of the present invention provides a relatively compact design which is easy and economical to manufacture and assemble and provides the necessary high seismic capabilities and significantly reduces the space requirements as compared with prior assemblies. For example, the rack in accordance with the present invention is about 4 inches wider than the battery width and this is significantly smaller than current rack designs for the C&D LCT-2320 which have widths equaling about 9 and a half inches plus the battery width. Further, a modular 16 volt subsystem design in accordance with the present invention allows virtually unlimited configurations, for example, in areas where a long straight run of about 15 feet for a traditional 48 volt system battery rack is not available.

Further, the installation of a system with a rack according to the present invention is simplified by the fact that small modular units can be partially assembled positioned and anchored in place. Thus, this design facilitates drilling anchor holes through the rack base while the rack is in its final position. Moreover, the design of the present invention obviates the need for protruding corner brackets which consume additional space by reason of the fact that the end rails are not secured directly to the end frames.

There is shown in Figs. 5-9 inclusive another embodiment of the Battery Rack in accordance with the present invention generally designated by the numeral 14 and referred to herein as MFR-1A. This embodiment is generally similar to the previously described embodiment in terms of its basic components and is designed to provide an even smaller minimum footprint rack (MFR-1A) particularly in terms of the width W of the footprint. Thus, each end frame 16 comprises a C-shaped vertical member wherein the side flanges 19 are connected by a web 19a having in the present instance two (2) window-like openings 19b which provide for ventilation of the batteries and access for running cables and connector terminal plates so that the top and bottom tiers of the batteries can be electrically connected as shown in Fig. 5. The end frames 16 have mounting holes 17 for the shock rails 15 and diagonal braces 24. In this instance, the side flanges 19 at their lower ends have an inwardly directed gusset 19c and the external triangularly shaped gussets 23 are welded to the outer side edges of the base plate 22 outboard of the anchor holes 22a. The spacing of the triangular gussets 23 outboard of the anchoring holes 22a permits maximum spacing of the anchoring bolts which has the effect of minimizing anchor loads when the rack is experiencing front to back acceleration forces or loads.

As shown in Fig. 8, the flat base plate 22 has four (4) anchor holes 22a and notches 22b in the outer side edges to receive tabs 19c depending from the side flanges 16a to position the end frame relative to the base when the components are welded at final assembly. The triangular gussets 23 connect to the frame upright flange 19 and base plate 22 in alignment with the side flanges 19 to strengthen the joint between the upright 19 and the base plate 22. The base assembly B further includes a base channel 21 which incorporates mounting holes 21a for mounting a plurality of support rails 25 in the top

flange 21b. The base channel 21 is welded between the upstanding flanges 19 and the web 19a connecting the flanges 19 and the base plate 22 to form an integral assembly.

This system provides a somewhat narrower footprint than the previously described embodiment for reason of the end frame configuration and the use of narrower shock rails 15. However, in this instance, additional shock rails are used to provide a seismic strength and cell clamp assemblies 18 are utilized to transfer load between the shock rails on either side of the battery. A shorter footprint in a length wise direction L is achieved by eliminating the end rails 4 wherein the batteries bear directly against the end frames 16 in the manner shown.

This embodiment fulfills the design criteria set forth on pages 8 and 9 of the MFR embodiment. Thus, the rack width W in the present instance is reduced to 2.625 inches plus the battery width which is significantly smaller than prior art rack designs. The modular 16 volt subsystem design facilitates virtually unlimited configurations in areas where a long, straight run of about 15 feet for a traditional 48 volt system Battery Rack is not available. Installation is simplified by use of smaller modular units which can be partially assembled, positioned and anchored in place. The design facilitates drilling anchor holes through the rack base when the rack is in the desired location.

In the event long stretches of space are available in battery rooms, MFR-2 subsystems 27 may be bolted end-to-end with frame uprights 31 touching, thus not wasting valuable floor space. Joining plates 29 may be used to bolt frames 30 of adjacent racks 27 together or frames 30 of adjacent racks 27 may be bolted together directly through holes provided in the touching faces of the frames 30. A complete 48 volt system 28 is created when connecting 3 MFR-2 systems end-to-end in this manner. (See Fig. 15)

In some installations, more than one string of 48 volt batteries is required. Often the desirable layout is to have them run side-by-side (2 row). Utilizing spacer blocks 38, two 48 volt systems 28, consisting of 3 MFR-2's 27 each, may be bolted back-to-back using the same holes provided in the frame upright 31 flanges for joining plates 29 when adjoining MFR-2's end-to-end.

Although this Battery Rack was originally designed for one specific battery, it will have applications for many other battery sizes and types, some potentially larger and heavier. In order to still meet seismic requirements, in those cases fewer batteries than 8 will be supported by each rack. An MFR-2 system 40 that supports 6 batteries, 3 per tier, is ideal for this type of application. Wired in series, this produces a 12 volt system that can easily be strung together end-to-end to produce a 48 volt system 41. An alternative is to string 2 MFR-2 12 volt subsystems 40 end-to-end and again back-to-back to form a 48 volt system 42 (2 tier/2 row). (See Fig. 18)

In some cases, floor space may not be an issue and low ceilings may prohibit the use of 2-tier MFR-2's 27, 40. A 1-tier version 43 of the MFR-2 may be used in this instance. Its frame 44 is constructed the same as the 2-tier frame 30 except there is no upper horizontal 32. The base channels 33 are the same for both. The single tier MFR-2 43 hold 4 2 volt batteries yielding an 8 volt system, which can easily be strung together to form 24 volt or 48 volt systems. An alternative system for primarily larger batteries would hold 3 batteries for a 6 volt system. These again would string together nicely to form 24 volt or 48 volt systems. (See Fig. 20)

Where ceiling height is not limited and floor space is, a 3-tier MFR-2 46 may be implemented. In high seismic zones, the battery size for which this configuration would

work may be limited, however, where it is possible, 3 tiers of 4 2 volt batteries would yield a 24 volt system. This is ideal for creating 24 volt or 48 volt systems. Frame 47 construction would again be the same as the 2-tier MFR-2. The frame upright 48 would be taller and accommodate 2 upper horizontals 32 and one base channel 33, the same as used on the 2-tier MFR-2 frame 30.

There is shown in Figs. 9-13 still another embodiment of rack assembly 27 in accordance with the present invention. This embodiment is generally similar to the previously described embodiments in that it achieves a small footprint and is referred to herein as MFR-2. Additionally, several features were added to increase the range of applications relative to different battery sizes, system configurations and layouts.

In accordance with this embodiment battery system which is generally designated by numeral 27 and referred to herein as MFR-2 is generally constructed and installed in much the same manner as the previously described MFR-1 and Battery System. However, in the present instance, the construction of the end frame 30 has been modified to produce a shorter footprint which facilitates attaching the battery racks end-to-end and back-to-back and reduces frame components and cost of manufacturing assembly. The MFR-2 frame design comprises a c-shaped end frame 30 consisting of upstanding flanges 31A 31C connected by a web 31B the end frames are provided having two window openings 31a for ventilation and accommodate cables connecting the tiers of batteries as shown in Fig. 9 with a plurality of mounting holes for assembly of the shock rails 34 and diagonal braces 36.

Additionally, the end frames 30 incorporate four (4) holes 31D for attaching grounding lugs at the upper end of the vertical flanges 31a of the end frames. Further, the

end frames have two holes 31e near the middle of each vertical flange for mounting joining plates 29 and two holes 31f in the web 31b in the upper horizontal as attached for bolting MFR -2 rack assemblies end to end. The interior gussets 37 are formed integrally with the lower end of the flanges 31. A C-shaped upper horizontal brace 32 having holes 39 32a for mounting a plurality of support rails 35 is welded between the upright flanges 31a, 31a.

A C-shaped base channel 33 is nested at the lower end of the end frame and is positioned by interengaging tabs 41 which depend from the flange and engage in notches 33d in the baseplate 33. The channel 33 incorporates six (6) anchor holes 45 in its lower longer flange 33a and mounting holes 47 for a plurality of support rails in the upper shorter flange 33b and clearance holes 33c for drilling and passing anchors through in the upper flange and two ground lug attaching holes in its web. The benefit of 6 anchors verses 4 is one can use shallower embedment anchors, which may be necessary in some concrete floors due to thickness limitations. In those cases, MFR-1 or 1A may not be useable but MFR-2 is. Further, each upright flange has two holes near the upper end for mounting cable ladders support rails.

There is shown in Fig. 14 an alternate end frame configuration designated by the numeral 53. This end frame incorporates a base plate 54 into the C-shaped end frame which is bent at a 90° angle to the web 54a at the base. Accordingly, rather than utilizing a formed c-shaped channel for a base, this modified end frame 53 utilizes a formed angle 54 having a series of openings 57 for mounting a plurality of support rails to the top flange as well as clearance holes 59 for drilling or passing anchors to secure the end frame on a support surface or the like.

Even though particular embodiments of the invention have been illustrated and described herein, it is not intended to limit the invention and changes and modifications can be made therein within the scope of the following claims.